WATER CIRCULATION IN BOILERS

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OWING to the fact that water may be converted into vapor at rather low temperatures, there is no particular difficulty in constructing a boiler that will produce steam when heat is applied to it. The earliest boilers were modeled upon the familiar kitchen kettle. To-day there are so many different designs of boilers that it would be difficult to enumerate them. A few years ago boilers were operated and rated at the nominal figure of 10 sq ft of heating surface per boiler horsepower. To-day the nominal rating remains the same, but in practice the boiler is operated at from 150 to 300 per cent of rating. The water-tube boiler was devised to increase boiler efficiency by securing improved water circulation and breaking the circulating water up into multiple streams surrounded by hot gases. In this it has met a certain degree of success, as is proved by the modern method of boiler forcing.

The most widely used design of the water-tube boiler consists of one or more steam drums and an assemblage of inclined tubes, the pitch or slope varying from 8 per cent to 30 per cent. The tubes are generally arranged in multiple, but there are designs tha?t employ series operation of a number of multiple banks of tubes. Circulation generally depends upon the thermal syphon principle, that is, upon the hydrostatic head developed by the difference in weight of two columns of water of slightly different temperatures. Additional circulating velocity is supposed to be due to the fact that one of these columns of water is solid and the other partially displaced by steam bubbles.

The accompanying table shows the weights of water and steam at different temperatures, by 20° C.

increments, together with the corresponding pressures. At the boiling temperature, 100° C., the ratio between the weights of equal volumes of steam and water is about 1 to 1600, which is sufficient to supply an •ascensional velocity to the steam of about 177 m (580 ft) per second. At 200° C. the ratio drops to 1 to 110 and the ascensional velocity to 46.5 m (153 ft) per second. The coefficient of friction between the bubble of steam and the surrounding water is unknown, but even if an extremely liberal allowance is made for this